

Application No.: 10/731,163
Amendment Under 37 C.F.R. §1.111 dated October 27, 2004
Reply to the Office Action dated July 27, 2004

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

The following listing of claims replaces all prior versions and listings of claims in the application.

Claim 1 (Currently Amended): An electron beam apparatus, ~~in which an electron beam emitted from comprising:~~

an electron gun having a cathode and an anode ~~is focused and irradiated~~ for emitting an electron beam and for focusing and irradiating the electron beam onto a sample; ~~and secondary electrons emanated from said sample are directed into~~

a detector ~~;~~ ~~said electron beam apparatus characterized in further comprising means for optimizing irradiation of said electron beam from said electron gun onto said sample~~ for detecting secondary electron beams emanated from the sample; and

an electro-optical column has a condenser lens, and two-stage deflectors disposed between said condenser lens and said electron gun, wherein said two-stage deflectors deflect and direct an electron beam emitted from said cathode in a specific direction so as to be in alignment with an optical axis direction of said electron beam apparatus.

Claim 2 (Currently Amended): An electron beam apparatus ~~claimed in~~ according to claim 1, wherein ~~said optimizing means includes two-stage deflectors disposed in proximity to said electron gun, wherein said two-stage deflectors are adapted to deflect and direct an electron~~

Application No.: 10/731,163

Amendment Under 37 C.F.R. §1.111 dated October 27, 2004

Reply to the Office Action dated July 27, 2004

~~beam emitted from said cathode in a specific direction so as to be in alignment with an optical axis direction of said electron beam apparatus;~~ said electron beam emitted in the specific direction being at a certain angle with respect to the optical axis due to the fact that, among crystal orientations of said cathode, a specific crystal orientation allowing a higher level of electron beam emission is out of alignment with the optical axis direction.

Claim 3 (Currently Amended): An electron beam apparatus ~~as claimed in~~ according to claim [[2]] 1, wherein one deflector of said two-stage of deflectors, which is disposed closer to said electron gun, is ~~designed to be~~ an electromagnetic deflector and the other deflector of said two-stage of deflectors, which is disposed ~~in~~ closer to said sample, is ~~designed to be~~ an electrostatic deflector.

Claim 4 (Currently Amended): An electron beam apparatus ~~as claimed in~~ according to claim [[2]] 1, wherein the crystal of said cathode is composed of carbide, boride or nitride of transition metals.

Claim 5 (Currently Amended): An electron beam apparatus ~~as claimed in~~ according to claim 1, ~~wherein said optimizing means comprises said cathode, an anode having a potential near to that of said cathode and said anode,~~ wherein only an electron beam that has been emitted in a particular direction among a plurality of electron beams emitted in different directions from said electron gun is guided onto said sample, and the electron beams emitted in the directions other than said particular direction are absorbed into said anode ~~having a potential near to that of said cathode and thus discarded.~~

Application No.: 10/731,163

Amendment Under 37 C.F.R. §1.111 dated October 27, 2004

Reply to the Office Action dated July 27, 2004

Claim 6 (Currently Amended): An electron beam apparatus ~~as claimed in claim 1,~~ wherein ~~said secondary electrons emanated from an electron beam irradiated region on a surface of the sample are detected so as to evaluate the sample, wherein said sample has a partial region on the surface thereof which is relatively weak against dielectric breakdown which may be caused by electron beam irradiation, wherein said optimizing means is constituted as means for controlling irradiation of said electron beam so as not to be irradiated onto said weak region but to be irradiated exclusively onto the other regions~~ for evaluating a sample surface comprising:

an electron gun having a cathode and anode for emitting an electron beam and for focusing and irradiating the electron beam onto a sample surface;

a detector for detecting secondary electron beams emanated from the sample surface, wherein the sample surface having a partial region which is providing a relatively weak region against dielectric breakdown being caused by irradiating the electron beam; and

a controller for controlling the electron beam so as not to be irradiating the weak region, wherein the weak region having a gate oxide film of a transistor formed thereon and an electric connection with the regions of the gate oxide film.

Claim 7 (Currently Amended): An electron beam apparatus ~~as claimed in~~ according to claim 6, ~~wherein a region having a gate oxide film of a transistor formed thereon and a region having an electric connection with said region of gate oxide film are selected as said relatively weak regions against said dielectric breakdown~~ said electron beam apparatus comprises an electron optical system which produces a decelerating electric field for a primary electron beam between an objective lens and said sample.

Application No.: 10/731,163
Amendment Under 37 C.F.R. §1.111 dated October 27, 2004
Reply to the Office Action dated July 27, 2004

Claim 8 (Currently Amended): An electron beam apparatus ~~as claimed in~~ according to claim 6, wherein scanning operation of the electron beam is adapted to be applied over an entire surface of the sample, while said electron beam may be blanked when said electron beam is to scan said region relatively weak against said dielectric breakdown.

Claim 9 (Currently Amended): An electron beam apparatus ~~as claimed in~~ according to claim ~~[[6]]~~ 1, wherein said secondary electrons emanated from an electron beam irradiated region on a surface of the sample are detected so as to evaluate the sample, wherein a surface of a sample is segmented into a region relatively weak against dielectric breakdown and the other regions, wherein ~~said optimizing means is constituted as means for controlling said irradiation of said electron beam so that a different~~ small dose levels of the electron beam is applied to ~~each of~~ said respective ~~different~~ weak regions so as to evaluate the surface of the sample.

Claim 10 (Currently Amended): An electron beam apparatus ~~as claimed in claim 1,~~ comprising:

an electron gun having a cathode and an anode for emitting an electron beam and for focusing and irradiating the electron beam onto a sample; and

a detector for detecting secondary electron beams emanated from the sample,

wherein said electron beam emitted from said electron gun having a ~~thermionic emission~~ a hot cathode is irradiated against an aperture and the electron beam after having passed through said aperture is ~~contracted~~ reduced and projected onto said sample, two-stage of deflectors is operated to scan said sample, and said secondary electrons electron beams emanated from the sample are accelerated by an electric field produced by an objective lens and guided by an E x B separator into said detector, wherein ~~said optimizing means is constituted as means for~~ two-stage

Application No.: 10/731,163

Amendment Under 37 C.F.R. §1.111 dated October 27, 2004

Reply to the Office Action dated July 27, 2004

~~deflectors~~ ~~setting~~ set a pivot point of deflection ~~by said two-stage deflectors~~ in such a location that minimizes a transverse chromatic aberration in the proximity of said objective lens.

Claim 11 (Currently Amended): An electron beam apparatus as claimed in claim ~~[[1]]~~ 10, wherein said electron gun is ~~operative~~ operating under a space charge limited condition.

Claim 12 (Original): An electron beam apparatus as claimed in claim 10, wherein said aperture is square shaped.

Claim 13 (Currently Amended): An electron beam apparatus as claimed in claim ~~[[11]]~~ 10, wherein a negative voltage is applied to said sample and a voltage having a lower potential than that of said sample is applied to a lower electrode of said objective lens.

14 (Currently Amended): An electron beam apparatus for evaluating a sample surface as claimed in claim 1, ~~wherein said electron beam apparatus comprises an electron optical system which produces a decelerating electric field for a primary electron beam between an objective lens and said sample so that a focused electron beam can scan a surface of said sample, in which secondary electrons emanated from said sample, after having passed through said objective lens, are deflected from said optical system so as to be detected, comprising:~~

an electron gun having a cathode and anode for emitting a primary electron beam and for focusing and irradiating the primary electron beam onto the sample surface;

a detector for detecting secondary electron beams emanated from the sample surface;

an electron optical system having an objective lens for decelerating and scanning the primary electron beam onto the sample wherein the primary electron beam focused by the

Application No.: 10/731,163
Amendment Under 37 C.F.R. §1.111 dated October 27, 2004
Reply to the Office Action dated July 27, 2004

objective lens; and

a deflector for deflecting a secondary electron beam emanated from the sample from the electronic optical system to the detector, wherein the electronic optical system evaluating a flat wafer within a range defined in as an inner side from the periphery of the wafer by a distance greater than "R" mm, wherein said objective lens designed in a optimizing means is constituted as means for establishing such a dimensional relationship as represented by an expression:

$$W+D/2 \leq [[5]] \ R \text{ mm}$$

where "W" is a working distance of said objective lens, and "D" is a bore diameter of an electrode of said objective lens disposed in a location closest to said sample.

Claim 15 (Currently Amended): An electron beam apparatus as claimed in claim ~~[[1]]~~ 14, wherein said ~~electron beam apparatus is composed as a one which can evaluate a flat wafer within a range defined as an inner side with respect to the periphery of said wafer by a distance not smaller than "R" mm, by using an electron optical system having an objective lens of decelerating electric field type, wherein said optimizing means is constituted as means for establishing such a dimensional relationship as represented by an expression:~~

$$\underline{W+D/2 \leq 5 \text{ mm}}$$

where ~~"W" is a working distance of said objective lens, and "D" is a bore diameter of an electrode of said objective lens disposed in a closest location to said sample~~ R is 5.

16 (Currently Amended): An electron beam apparatus as claimed in claim ~~[[1]]~~ 14, wherein at least said objective lens has an electrode of axisymmetric structure made of an insulating material with a metal coating applied selectively onto a surface thereof.

Application No.: 10/731,163

Amendment Under 37 C.F.R. §1.111 dated October 27, 2004

Reply to the Office Action dated July 27, 2004

Claim 17 (Currently Amended): An electron beam apparatus as claimed in claim ~~[[14]]~~ 16, wherein a plurality of electron optical system~~[[s]]~~, ~~wherein at least said objective lens has an electrode of axisymmetric structure made of an insulating material with a metal coating applied selectively onto a surface thereof~~ having the features in of claims 14 to 16 is arranged in parallel above a sheet of sample, is arranged in parallel above a sheet of sample.

Claim 18 (Currently Amended): An electron beam apparatus ~~as claimed in claim 1~~ for evaluating a sample surface comprising:

an electron gun having a cathode and an anode for emitting an electron beam and for focusing and irradiating the primary electron beam onto the sample surface; and

a detector for detecting secondary electron beams emanated from the sample surface,

wherein said electron beam apparatus has an electron optical column configured such that an electron beam emitted from a thermionic emission cathode may be irradiated against said sample and either one of secondary electrons, back scattered electrons or absorbed electrons, which has been emanated from said sample, is detected in a detecting system, and

wherein said ~~optimizing means is constituted as means for~~ cathode is a thermionic emission cathode and is determining a value for a heating electric power of said thermionic emission cathode by evaluating a signal/noise ratio or a noise level detected in said detecting system during a period when said electron beam is irradiated against said sample while changing the heating electric power of said thermionic emission cathode.

Claim 19 (Original): An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined in such a manner that said signal/noise ratio exceeds a predetermined value or said noise level is not

Application No.: 10/731,163

Amendment Under 37 C.F.R. §1.111 dated October 27, 2004

Reply to the Office Action dated July 27, 2004

greater than a predetermined value when a certain level of beam current is applied to the sample from the electron beam emitted from said thermionic emission cathode.

Claim 20 (Original): An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined in such a manner that an increasing rate of said signal/noise ratio with respect to the heating electric power is not greater than a predetermined value or a decreasing rate of said noise level is not greater than a predetermined value when a certain level of beam current is applied to the sample from the electron beam emitted from said thermionic emission cathode.

Claim 21 (Original): An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined by evaluating a noise current/beam current ratio.

Claim 22 (Original): An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is tentatively determined in such a manner that a variation in an electron gun current observed during the period when the heating electric power of said thermionic emission cathode being changed is moderate, and following the tentative determination, the value for the heating electric power of said thermionic emission cathode is ultimately determined based on an evaluation of the signal/noise ratio or the noise level detected in said detecting system.

Claim 23 (Original): An electron beam apparatus as claimed in claim 18, wherein the value for the heating electric power of said thermionic emission cathode is determined in

Application No.: 10/731,163
Amendment Under 37 C.F.R. §1.111 dated October 27, 2004
Reply to the Office Action dated July 27, 2004

consideration of a relationship between the heating electric power of said thermionic emission cathode and said signal/noise ratio and another relationship between the heating electric power of said thermionic emission cathode and a lifetime of said thermionic emission cathode.

Claim 24 (Currently Amended): A device manufacturing method, ~~wherein an electron beam apparatus as defined in claim 1 is used to evaluate a wafer in the course of processing or a wafer of a finished product~~ comprising:

preparing wafers;

processing the wafer;

evaluating said processed wafers using electron beam apparatus as claimed in claim 6;

repeating said last two steps; and

assembling devices using said processed wafers.

25 (Previously Presented): An electron beam apparatus as claimed in claim 15, wherein a plurality of electron optical systems, wherein at least said objective lens has an electrode of axisymmetric structure made of an insulating material with a metal coating applied selectively onto a surface thereof, is arranged in parallel above a sheet of sample.

26 (Previously Presented): An electron beam apparatus as claimed in claim 16, wherein a plurality of electron optical systems, wherein at least said objective lens has an electrode of axisymmetric structure made of an insulating material with a metal coating applied selectively onto a surface thereof, is arranged in parallel above a sheet of sample.